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HAWAII AGRICULTURAL EXPERIMENT STATION.

J. G. SMITH, SPECIAL AGENT IN CHARGE.

BULLETIN No. 10.

INSECT ENEMIES OF TOBACCO IN HAWAII.

BY

D. L. VAN DINE,

ENTOMOLOGIST, HAWAII AGRICULTURAL EXPERIMENT STATION.

UNDER THE SUPERVISION OF

OFFICE OF EXPERIMENT STATIONS,

U. S. Department of Agriculture.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1905.

HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

[Under the supervision of A. C. True, Director of the Office of Experiment Stations, United States Department of Agriculture.]

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LETTER OF TRANSMITTAL.

HONOLULU, HAWAII, *May 31, 1905.*

SIR: I have the honor to transmit and recommend for publication as Bulletin No. 10 of this station the following article on Insect Enemies of Tobacco in Hawaii, by Mr. D. L. Van Dine, the station entomologist.

Much of the material in this bulletin has appeared serially in the Hawaiian Forester and Agriculturist during the past year, but the increased interest in the growing of tobacco in Hawaii and inquiries regarding the insect enemies of the crop make it advisable to publish this information in a revised form as a bulletin of this station, for general distribution throughout the Territory.

Very respectfully,

JARED G. SMITH,
Special Agent in Charge of the Hawaii Agricultural Experiment Station.

Dr. A. C. TRUE,
Director, Office of Experiment Stations,
U. S. Department of Agriculture, Washington, D. C.

Recommended for publication.

A. C. TRUE,
Director.

Publication authorized.

JAMES WILSON,
Secretary of Agriculture.

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INSECT ENEMIES OF TOBACCO IN HAWAII.

As the results of the experiments at Hamakua in 1904 seem to indicate there is a possibility of tobacco growing being added to Hawaii's diversified agriculture, it is believed desirable that those interested in the subject should be informed concerning the tobacco-feeding insects already present in the islands. Necessarily little can be said regarding their local status or the methods that will prove most effective and applicable for their control here. However, the planter's ability to recognize the species injurious to tobacco, the symptoms of their attack and a knowledge of remedies found to be effective elsewhere, will be the principal equipment needed to wage war successfully against the enemies of this crop. Detailed accounts of their life cycle, the time, or rather, in Hawaii, the times of their appearance, their relative injurious importance, and definite advice for their control must follow field cultivation. The writer has relied chiefly on Doctor Howard's bulletin, The Principal Insects Affecting the Tobacco Plant,[a] and on the work of Quaintance[b] in Florida, and Garman[c] in Kentucky for the following information:

CUTWORMS.

The cutworms are the young or larvæ of moths whose habits in general are to hide during the day beneath rubbish or in the loose soil and come forth at night to feed. They derive their common name from the fact that they eat through or cut off at the surface of the ground the plants upon which they feed, thus destroying more than they actually take as food. The most destructive cutworms in Hawaii are species of a single genus, Agrotis, some of which are peculiar to the islands. The native name is "peelua," from "pee," to hide and "lua," a hole, referring to the manner in which the worms conceal themselves by burrowing into the soil during the daytime. One early writer says:

> The origin of the Hawaiian peelua can not be determined. No person living can settle the date of its arrival, if it ever came. The oldest native when asked the question, "When did the peelua come?" will answer, "Oia mau no" [it has always been there].[d]

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[a] U. S. Dept. of Agr., Farmers' Bul. 120, 1900.

[b] Florida Experiment Station Bul. 48, 1898.

[c] Kentucky Experiment Station Buls. 49, 58, and 66, 1894, 1895, 1896.

[d] J. E. Chamberlain. Hawaiian Almanac and Annual, p. 46, 1883.

These pests are the most serious of the vegetable-feeding insects and work great destruction likewise in grass lands. Thus far they have proved the greatest pest of the tobacco plants in the Hamakua experimental field of this station, attacking the newly-set plants in the field. The species most destructive to tobacco will no doubt prove to be the so-called greasy cutworm.

THE GREASY CUTWORM.

(*Agrotis ypsilon* Rott.)[a]

This insect is widely distributed in Canada and the United States and occurs also in Europe. Howard records it as "one of the tobacco cutworms" and Quaintance believes it to be "the more common insect destructive to tobacco" in the State of Florida.

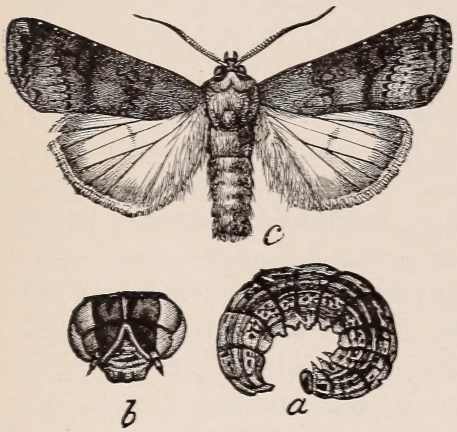

FIG. 1.—The greasy cutworm (*Agrotis ypsilon*). *a*, Larva in characteristic position; *b*, head of larva; *c*, adult moth—natural size (from Howard).

The eggs are laid in the lower portions of the stem or leaves of various plants, and the larvæ, on hatching, feed on the young succulent portions of their food plants, which, in the cultivated varieties, include nearly all products of the vegetable garden, and such field crops as tobacco and corn. The larva and adult can be recognized from the accompanying illustration (fig. 1).

The head of the larva is darker than the body, the latter being of a dull brown, varying to gray. It is distinguished by the characteristic greasy appearance of the skin. When full grown the larva is about 1½ inches long. The very young larvæ are comparatively slow in their development and may be several months in reaching the advanced larval stages when, because of their increased size and greater destructiveness, they become conspicuous.

REMEDIES.

To wait until the cutworm makes its appearance in the tobacco field will mean in many cases a loss of a large percentage of the plants. This insect is to be controlled mainly by so-called poisonous baits applied before symptoms of the insect's work are noticed, or even before the plants are transferred from the seed beds to the field. Newly prepared lands, especially those recently cleared or adjoining uncultivated areas; areas grown to any of the food plants of this pest,

[a] Meyrick. Fauna Hawaiiensis, Vol. I, Part II, p. 143, 1899. *A. suffusa* and *A. telifera* are synonyms.

or prepared lands previously given to some cutworm crops, will harbor numberless specimens of this and other species of cutworms. The idea in control is to take advantage of the insects' fondness for some substance aside from the young tobacco plants and destroy them by adding to this substance a poison. Doctor Howard says:

> After the field is plowed and is bare of vegetation and ready for planting, if the tobacco grower will thoroughly spray a patch of grass or weeds with Paris green and water and will then cut it and drop it in little bunches here and there throughout the tobacco field, he will find that the cutworms in the soil, in the absence of other food, will eat this poisoned vegetation and will be destroyed, so that the tobacco plants can be set out without fear of damage.

Since the cutworms work at night, the vegetation thus treated should not be cut until toward evening, so that it may be as fresh as possible.

Another poisoned bait is prepared by mixing Paris green or some other arsenical poison with bran. Regarding its use against cutworms in tobacco fields Quaintance says:

> This bait should be prepared by thoroughly mixing Paris green with bran at the rate of 1 pound of Paris green to 50 or 75 pounds of bran. Just before a quantity is to be used it should be moistened slightly with water sweetened with molasses. A small ring of the poison should be strewn around each newly set plant, or a teaspoonful placed at two or three places. The cutworms seem to prefer this even to tobacco, of which they are inordinately fond. Where seed beds are badly infested with cutworms this poisoned bran should be drilled along in various parts of the bed where it will be readily accessible to them. This poisoned mixture should be renewed around the plants about every third day to keep it most appetizing for the larvæ. Care must be taken that it is not accessible to fowls or stock.

Since the cutworms are so generally abundant in the islands and the tobacco-feeding species, *Agrotis ypsilon* in particular, so destructive, it would be well to apply, as Howard recommends in the case of the poisoned vegetation, the Paris green-bran mash mixture to the prepared land several days before setting out the young plants. It can be strewn broadcast over the entire field.

THE TOBACCO FLEA-BEETLE.

(*Epitrix parvula* Fab.)

This widely distributed species is first recorded from Hawaii by Doctor Sharp[a] from the islands of Oahu and Molokai on the poha, *Physalis peruviana*. According to Mr. Schwarz, of the Bureau of Entomology, U. S. Department of Agriculture, who kindly identified the insect, the beetle was introduced into the Hawaiian Islands from Central America. The writer has received specimens taken from tobacco and has collected others from tomatoes. Other food plants

[a] Fauna Hawaiiensis, Vol. II, Part III, p. 95, 1900.

are the potato and various weeds belonging to the plant family Solanaceæ. In appearance—

The adult beetle is very minute, measuring scarcely above one-twentieth of an inch in length, oblong ovate in form, and light brown in color. The elytra (wing covers) are usually marked with a dark transverse median band of greater or less extent.[a]

The tobacco grower will be able to recognize the insect by its flea-like manner of jumping when disturbed and the accompanying illustration (fig. 2).

The eggs are laid at or near the roots of the food plant, and the young on hatching enter the soil and feed on the young roots. The adults feed on the leaves of the tobacco. Their work is indicated by either small brown spots or minute holes. The adults are chewing insects and gnaw off and swallow portions of the leaf. As the insects continue feeding these small holes increase in size, and badly damaged leaves become very ragged in appearance.

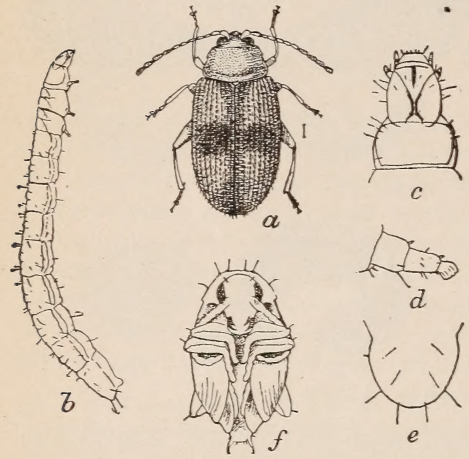

FIG. 2.—The tobacco flea-beetle (*Epitrix parvula*). *a*, Adult beetle enlarged about fifteen times; *b*, young larva; *f*, pupa; *c*, *d*, *e*, portions of the larva greatly enlarged (from Chittenden).

REMEDIES.

The flea-beetle usually destroys only the first few leaves of the larger plants. The standard remedy in the tobacco districts on the mainland is Paris green applied as a spray in the proportion of 1 pound of Paris green to about 100 gallons of water. In the use of Paris green the operator should know that the substance is insoluble, or very slightly soluble, in water. The fact that the minute crystals of Paris green are only in suspension makes it necessary to keep the mixture of Paris green and water constantly stirred to have the spray of uniform quality. If the mixture is not constantly agitated, a portion of the plants will receive little or none of the poison and those sprayed last—that is, with the mixture in the bottom of the spraying outfit—will get the larger part of the Paris green. This undue amount will burn the leaves and might cause considerable damage if by chance the Paris green is of low grade.

As in dealing with cutworms, preventive measures will be found the most desirable method of controlling the flea-beetle. Regarding this method of control Doctor Howard says:

The destruction of weeds, particularly solanaceous weeds, along the margins of the field, will be of positive benefit in reducing the numbers of this insect, as well as

[a] F. H. Chittenden. U. S. Dept. Agr., Bureau of Entomology Bul. 10 (n. s.), p. 80, 1898.

other tobacco insects, unless (and this suggestion we make as one of much possible value) it shall be found feasible to grow a few clumps of nightshade or jimson weed as trap crops for the beetles, the plants to be thoroughly poisoned in the early summer before the tobacco has been set out. The tobacco crop is one of a few which are peculiarly adapted to this kind of remedial treatment. In the ordinary course of tobacco culture the weeds are allowed to grow freely about the margins of the fields. Before the tobacco plants are set out those weeds which are secondary food plants of tobacco insects, such as *Solanum nigrum*, *Solanum carolinense*, and *Datura stramonium*, act simply as concentrators and multipliers of the tobacco insects, so that the insects are already in force about the margins of the fields, ready to transfer their attentions to the young and succulent tobacco plants after they have been planted. From this it is plain that if the margins of the fields are kept free from such plants, the insects will not have as good a start and will not be present in such great numbers. It also follows that if a few attractive weeds are left in clumps the flea-beetles and other tobacco insects of the immediate vicinity will concentrate upon these few weeds, where they can readily be killed, either by the application of an arsenical poison, if they are gnawing insects, or of a kerosene emulsion, if they are sucking insects.

We have in Hawaii many representatives of the plant family Solanaceæ, among which are the following very common forms: The cape gooseberry (*Physalis peruviana*), the "poha" of the natives; the jimson weed (*Datura stramonium*), known locally as "kikania;" and *Solanum nodiflorum*, whose native name is "popolo."

Care should be taken not to grow such crops as tomatoes and potatoes adjoining tobacco fields, unless these crops receive the same careful culture as prescribed for tobacco, and after harvesting both the tobacco and these crops all stalks and vines should be collected and destroyed, thereby preventing the further breeding of any forms of tobacco insects left in the field.

THE TOBACCO SPLITWORM.

(*Phthorimæa operculella* Zell.)[a]

The tobacco splitworm or leaf miner is the well-known "potato tuber moth" of California, the Mediterranean countries, New Zealand, and Australia. A stem of a tobacco plant infested with a single specimen of the larva of this insect was received from the Hamakua experimental field (Pohakea, island of Hawaii) the latter part of February, 1904. The adult moth was bred and forwarded to the Bureau of Entomology, U. S. Department of Agriculture, for identification. The determination was kindly made by Mr. August Busck. During the past season the injury by this pest to the tobacco plants has been considerable and the splitworm promises to be one of the insects that will seriously affect tobacco in Hawaii. The insect was probably introduced into the islands in potatoes from California, although it may have arrived in the stewards' supplies from either Australia or China.

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[a] *Lita solanella*, *Gelechia solanella*, *G. operculella*, etc., are synonyms.

It was first recorded as a tobacco pest on the mainland in 1897 by Mr. Gerald McCarthy.[a]

The small size of the larva will render its presence difficult of detection, at least in the early stages of development. The occurrence of the splitworm in the tobacco field will probably be first noticed by the symptoms of its work. This insect receives its common name because of its habit of mining between the upper and lower surfaces of the leaf, causing not only a blotch visible from either side, but frequently a deformity as well. The portions of the leaves thus affected become at first lighter in color and finally dry and parchment-like. While the parts of the leaves remain intact, their value is greatly lessened, especially for wrapper purposes.

The eggs are deposited on the leaves and the young minute larvæ, on hatching, gnaw at once to the tissues between the epidermal layers.

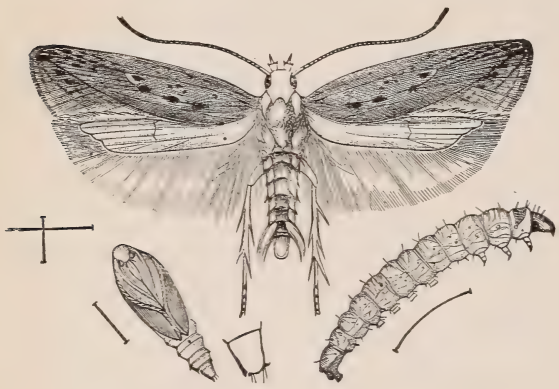

FIG. 3.—The tobacco splitworm (*Phthorimæa operculella*). Moth shown above; "splitworm" or larva below at right; pupa below at left—all enlarged; natural size shown by hair lines (from Howard).

On reaching maturity the larvæ drop to the ground and, after first spinning a slight silken cocoon, pupate beneath the loose soil or among the rubbish found at the surface. Mr. Warren T. Clark[b] sums up the life cycle of this insect as follows:

To complete the cycle ordinarily, 63 to 69 days are needed, save for the winter generation, when this time may be extended to 84 or 85 days; this, of course, under the temperature conditions of Berkeley. This time is divided thus: Egg state, 7 to 10 days; larvæ, 42 to 45 days ordinarily, winter generation, 9 weeks; chrysalis, 14 to 16 days; adult life, indefinite, but short.

In the equable climate of these islands the life cycle is undoubtedly shorter than this, and at least two generations are possible during the growth of one crop.

REMEDIES.

Under this heading Mr. McCarthy says:

Clean cultivation of the growing crop, with frequent stirring of the soil close up to the plants, will destroy the dormant pupæ or cover them so deep that the moth will be unable to find its way to the surface of the ground. A close watch should be kept, and when blotch mines are seen on leaves the inclosed caterpillar may be easily crushed between the thumb and finger. The leaves will then soon repair the damage.

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[a] A New Tobacco Pest. North Carolina Experiment Station Bul. 141, 1897.

[b] The Potato Worm in California. California Experiment Station Bul. 135, 1901.

It would seem that this pest, feeding as it does within the leaf, is not susceptible to treatment with poisons placed on the surface. This would be true were it not for the habit of the larva to migrate from place to place, as pointed out by Mr. Quaintance. He says:

> In feeding a larva does not pass its entire life at one place, but after eating for a while it will chew to the outside, and after crawling around over the leaf will enter the tissue again in a new place. A knowledge of this migratory habit is possibly of value, as it suggests a means for treating this insect, in that it must chew the outside of the leaf to some extent in leaving and entering the leaf, and hence might be poisoned. As a rule, the lower five or six leaves are infested worse than those higher up on the plant.

From the above it is evident that an arsenical spray, such as the Paris-green mixture recommended for the flea-beetle, will also be effective for the splitworm. It is well, however, to emphasize again cultural methods and preventive measures. For example, if the plants are sprayed before the eggs hatch, the very young larvæ will be killed in attempting to gnaw through the surface of the leaves. All solanaceous weeds about the field should be destroyed as well as badly "blotched" leaves and infested stalks. After harvesting the crop all stalks, stumps, and rubbish should be collected and burned, since many of the larvæ and pupæ, and possibly hibernating moths, will be destroyed, which will greatly reduce the numbers of the pest likely to attack the following crop.

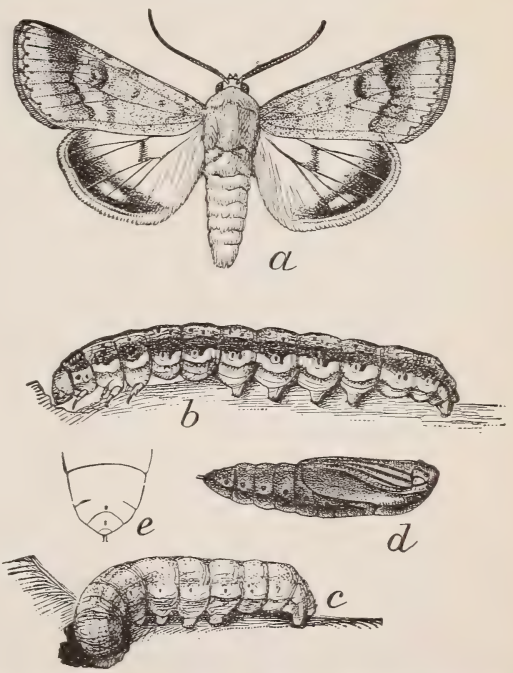

FIG. 4.—The false budworm (*Heliothis obsoleta*). *a*, Adult moth; *b*, dark full-grown larva; *c*, light colored full-grown larva; *d*, pupa—natural size (from Howard).

THE FALSE BUDWORM.

(*Heliothis obsoleta* Fab.)[a]

This pest is widely distributed in the United States and southern Canada and is a very general feeder. The principal products subject to its attack are the ears of maize, cotton bolls, the fruit of the tomato, and the buds and seed capsules of tobacco. Other food plants recorded are pumpkins, peas, beans, and hemp. Meyrick records the species from the islands of Hawaii, Maui, and Lanai, and Blackburn from Maui and Oahu.[b]

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[a] *H. armiger* and *H. conferta* are synonyms.

[b] Fauna Hawaiiensis, Vol. I, Part II, p. 152, 1899.

The false budworm is not a tobacco pest primarily, but in the absence of other food plants will infest the young tobacco buds. The insect is most widely recognized under the name the "cotton bollworm" of the Southern States. Regarding its appearance in tobacco fields, Doctor Howard says:

> The eggs are deposited in the bud, and the larvæ do very serious harm by feeding on the young and as yet unfolded leaves. A large worm may quite devour a bud. In color and markings the false budworm is one of the most variable of caterpillars. On tobacco the writer has found specimens of a uniform, light-green color, without spot or stripe, and others the general effect of which was nearly black. This insect, like the true budworm, passes the winter in the pupa condition under the surface of the ground.

Even if the young buds are not destroyed the resulting holes would prohibit the use of the leaves for wrappers.

REMEDIES.

Cultural methods as already outlined and the arsenical mixtures as recommended for the flea-beetle and the splitworm will control the false budworm under ordinary conditions. Should it occur in any numbers, special efforts must be directed toward its destruction. Mr. Quaintance thus describes a common practice in Florida:

> A very usual practice, and one that has proven to be quite satisfactory, is to sprinkle poisoned corn meal in the bud. The poisoned mixture should be prepared as follows: To a quart of finely ground corn meal add a half teaspoonful of Paris green and mix thoroughly by stirring. To apply this, a sprinkler should be made by using a baking-powder can, in the lid or bottom of which numerous holes have been punched so that, when it is shaken, the poisoned corn meal may be peppered over the bud. The poison should be applied frequently, and after heavy rains. In the case of large plants it may be necessary to open the buds with the hands and drop in a pinch of the poison.

THE TOBACCO HORNWORM.

(*Phlegethontius quinquemaculata* Haw.)[a]

The larva of this Sphingid moth is one of the "hornworms," so named because of the peculiar ornamentation at the rear end of the body, and is one of two species of this group affecting tobacco. This hornworm is commonly known in the United States as the northern tobacco worm, likewise as the tomato worm, and is probably the best-known representative of the larvæ of this family, since specimens can always be found wherever the principal food plants, tomatoes, tobacco, and potatoes, are growing throughout America.

The insect is recorded from these islands by Meyrick.[b] It was collected and previously recorded by the Rev. Thomas Blackburn.

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[a] *Sphinx celeus*, *Protoparce celeus*, *P. blackburni*, etc., are synonyms.

[b] Fauna Hawaiiensis, Vol. I, Part II, p. 193, 1899.

The long, cylindrical greenish worm with its peculiar markings and sphinx-like appearance when at rest, the brown-colored pupa supplied with the handle-like tongue case, uncovered at times from its earthen cell beneath the ground, and the huge moth with the broad wing expanse are easily recognizable in the accompanying figure. The illustration of the larva brings to mind, no doubt, a common natural-history object more or less repulsive and perhaps heretofore unassociated with the gorgeous moth shown below.

FIG. 5.—The tobacco hornworm (*Phlegethontius quinquemaculata*). *a*, Adult moth; *b*, full-grown worm or larva; *c*, pupa—natural size (from Howard).

REMEDIES.

While the great size of these larvæ makes it possible for a comparatively few individuals to work considerable damage, on the other hand, they are easily observed and can be kept below the "danger line" by hand picking them from the plants. Howard says:

In ordinary seasons and in certain localities the tobacco crop will not suffer so severely that it can not be protected by the ordinary process of hand picking, or

"worming," as it is called. Most conservative tobacco planters send their hands through the fields to pick off the caterpillars and crush them, and rely upon no other remedial work.

Should the hornworm prove too numerous and the practice of hand picking too expensive, the plants must be sprayed with an arsenical poison, either Paris green or arsenate of lead. The application of Paris green has already been fully discussed. From experiments conducted by Professor Garman in Kentucky, it appears that the young worms are more susceptible to the poison than the more fully matured ones. The plants should be watched for the appearance of the young worms, and if spraying is to be done at all, it should be done at this time. A mixture at the rate of 1 pound of Paris green to 125 to 160 gallons of water has been found sufficient if the worms are not over half grown in size. During the eight or ten days preceding harvesting the crop, the tobacco plants should not be sprayed. This precaution will insure practically none of the poison remaining on the leaves.

Concerning the use of arsenate of lead against the hornworm, Mr. Quaintance says:

> Its advantages over Paris green are that it is insoluble in water, and hence can be used of any desired strength without burning or spotting the foliage; it is quite adhesive and will remain on the foliage longer, thus obviating the more frequent sprayings or dustings necessary with Paris green; it is white in color, and hence is visible on the foliage, and thus lessens the danger from poisoning.

Directions for preparing arsenate of lead are given on page 14 of Bulletin No. 3 of this station, which will be mailed to any person in the Territory on request. Arsenate of lead, already prepared for use, is now on the market, both as a dry powder and in paste form. One such preparation, in paste form, is for sale in Honolulu.

Quaintance mentions another method of interest in combating the hornworm. He writes:

> It remains to speak of another means that is much used in this State (Florida) to lessen the number of hornworms. The fight is waged, however, against the adults by using flowers of jimson weed (*Datura stramonium*) and sweetened water poisoned with cobalt. Late in the evening a quantity of the bloom of the jimson weed is procured and is placed promiscuously through the patch, in holes in horizontal slats, supported by sticks or otherwise, and into the flower is placed by means of a quill a small quantity of this poisoned mixture. This poison should be of about the following proportions: Cobalt, 1 ounce; molasses or honey, one-fourth of a pint; water, 1 pint. The adults in their search for nectar frequent these flowers, and are thus poisoned by this mixture, which they feed upon greedily.

Doctor Howard, under the subject of remedies for the hornworm, emphasizes the necessity of removing all worms from the plants after or during cutting for the reason that if this is not done the worms will continue feeding on the leaves in the barn.

THE JAPANESE ROSE BEETLE.

(*Adoretus umbrosus* Fab.)
var. tenuimaculatus Waterhouse.

This destructive beetle, first known locally as the "rose bug" and the "Japan bug," made its appearance in and about Honolulu in the autumn of 1891. The pest attracted widespread attention throughout the islands because of its vicious attack on the roses, which up to that time since the early days of their introduction had been luxuriant in growth and profuse in flowers. This insect is first recorded from the Hawaiian Islands by Riley and Howard in Insect Life in 1893. Professor Koebele in his reports as entomologist to the Hawaiian government for the biennial period ending 1897 and the year ending 1898 records the insect as generally distributed and abundant on the islands of Oahu, Maui, Kauai, and Hawaii. The beetle is, according to Koebele, presumably a Japanese introduction, having been brought to the islands in the larval state in the soil about the roots of plants.

In regard to the life history of the Japanese rose beetle, Professor Koebele says:

> In Japan, where the temperature will probably allow the larvæ but six months active life, it may be that there it has but a single annual brood, and with the many enemies present it is no wonder that the beetle in consequence can be called rare. I have had the larvæ barely out of the eggs in Honolulu, and yet in three weeks later they were full-grown upon the decayed manure—not in general use in Japan—where they doubtless fed upon decayed vegetable matter, as they also do on the islands. The elongate small white eggs hatch in about seven to ten days, and the pupæ give forth the mature insects in from ten to fourteen days. Thus it will be seen that the whole transformation takes from six to seven weeks in summer at Honolulu.

While the Japanese rose beetle from the first showed a decided preference for the rose, it has, however, gradually extended its range of feeding, which now includes a great variety of food plants. Following the almost complete disappearance of the rose, the grape was severely attacked. So general did the feeding habits of this pest become that practically all dooryard and garden plants were to a greater or less extent injured. The food plants recorded by Professor Koebele are roses, orange, coffee, peach, guava, alligator pear, pomegranate, Java plum, grape, umbrella tree, various palms, sunflower, violets, Mexican vine, taro, and cane leaves. In regard to its food plants in Japan, Koebele says:

> I met with the insects while collecting in the forests, where they fell in my umbrella quite frequently during the summer around Yokohama, especially while beating for the various Coccinellidæ on oak, alder, and many other forest trees upon which they feed at night. Not in one instance did I see a specimen in a garden.

Since taro and sugar-cane leaves have already been recorded in the list of food plants, it is not entirely a new departure to discuss this

pest, essentially a horticultural one, as feeding upon a field crop. The insect is night flying and feeds only after nightfall, secreting itself during the day in the loose soil beneath its food plant, among rubbish on the ground, or in crevices such as found between the stem or trunk of a plant and the soil.

REMEDIES.

Hand picking in the seed beds will free the seedlings from this pest in one or two nights. If thereafter the seed beds are protected by a covering after sundown, relief from further injury will be secured. A box frame with cloth across the top could be cheaply made for this purpose, easily handled, and would last for several seasons.

The greatest injury to tobacco from the Japanese rose beetle will doubtless occur in the field, for the reason that this insect feeds, as a rule, on the more matured leaves of plants. The beetle may not prove to be a serious tobacco pest, as it might possibly have invaded the experimental plat from neighboring plants where it had exhausted its primary food supply. Should the work of the pest become serious in the field, it can be controlled by an arsenical poison as for the flea-beetle and splitworm. Arsenate of lead has been used with success against this pest on roses and other ornamental plants. Regarding a remedy for the beetle on roses, Professor Koebele says:

> One ounce of Paris green mixed with 4 pounds of flowers of sulphur, and dusted thickly over the rose and other affected plants, has so far proved one of the best remedies against that serious pest, the so-called rose bug, *Adoretus umbrosus*.[a]

THE CIGARETTE BEETLE.

(*Lasioderma serricorne* Fab.)

Having considered the pests of the growing tobacco plant, we now pass to one injurious to the cured and manufactured product. The cigarette beetle is the most common and destructive pest of stored products in the islands, infesting groceries, drugs, and cured and dried products indiscriminately, possibly favoring tobacco in its many manufactured forms. At this station it has been most annoying in its injury to the herbarium and specimens of dried fodder plants which had been ground for analysis. It has been bred from cigars, red pepper, and fish guano. Adults have been received from correspondents in cigars, in a preparation sold under the name of "paprika," and in a patented stock food. A local cigar firm recently received a shipment of several thousand cigars from Manila almost ruined by this pest. By taking the proper remedial measures, their storeroom did not become infested. The remedy consisted in fumigating the lot

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[a] Report of Entomologist. Biennial Report of the Minister of the Interior, Provisional Government of the Hawaiian Islands, p. 101, 1894.

with the fumes of carbon bisulphid. Since the beetles had already bored their way through the wrappers, they must have infested the tobacco in the factory at Manila.

Rev. T. Blackburn records this species from Oahu and Kauai and refers to it as "plentiful in Honolulu; frequently found in cigars."[a]

This insect occurs in all stages of development at the same time and generation follows generation successively throughout the year here in Hawaii.

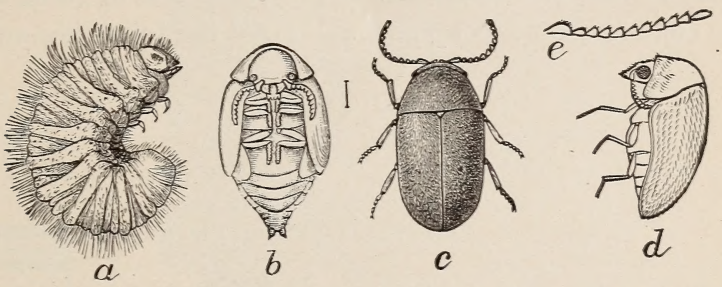

FIG. 6.—The cigarette beetle, *Lasioderma serricorne*. *a*, larva; *b*, pupa; *c* and *d*, adult; *e*, antenna—greatly enlarged—natural size shown by hair line (from Chittenden).

REMEDIES.

In speaking of ridding an establishment of this pest, Doctor Howard writes as follows:

The writer knows of one little shop into which it (the beetle) was accidentally introduced in some plug tobacco. It increased, entered the show cases, and ruined a large number of high-priced cigars and cigarettes. The shopkeeper was in despair, but finally, at the advice of the writer, submitted his entire stock to fumigation with bisulphid of carbon, and thus completely rid his establishment of the beetle.

With a small establishment like the one just mentioned, it is a comparatively simple matter to destroy the insect by means of the fumes of bisulphid of carbon. The place was clean and well-swept and dusted, and all that was necessary was to have a tight case (a show case was used), and the entire stock of tobaccos, cigarettes, and cigars was placed in the case in installments, and a saucerful of bisulphid of carbon was evaporated overnight. For some time after this experience the shopkeeper in question used the same case as a quarantine box, and put all of the tobacco which he bought through the fumigating process before he placed it on his shelves.

Following this plan, a local dealer cleared his storeroom of the cigarette beetle, and a grocer firm, using a paper-lined packing case with a tight-fitting cover, instead of the show case, successfully treated various stored products for this and other insect pests. Care must be taken that the carbon bisulphid is placed in shallow dishes in order that as great an evaporating surface is obtained as possible; that the dish is placed on top of the articles to be fumigated, since the fumes are heavier than air; that the box or room in which the fumigating is

[a] Memoirs on the Coleoptera of the Hawaiian Islands. Trans. Royal Dublin Soc. (2) III, p. 243, 1885.

done is absolutely air-tight, and that no fire of any sort is allowed near the room or building during the process and until after the place has been thoroughly aired. The resulting gas is so obnoxious that there is little danger of poisoning by inhalation. Practically the only danger in the use of this substance is the danger of fire, since it is highly inflammable and explosive. The carbon bisulphid is used at the rate of 1 pound of the liquid for every 1,000 cubic feet of space. The treatment may be done just before nightfall, when no light will be necessary, allowed to remain in the receptacle or room overnight, and the container opened up and well aired the following morning.

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